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ABSTRACT

This document lists the mathematics education goals for the end of grade three in New Hampshire schools. The main areas of goals and outcomes include: problem solving and reasoning; communication and connections; numbers, numeration, and operations; geometry and measurement; and data analysis. Each section contains curriculum goals, purpose, performance outcomes, and performance indicators for each goal. Contains 13 references. (MKR)

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MATHEMATICS CURRICULUM FRAMEWORK

End of Grade Three

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Introduction

Computational skills alone are no longer sufficient for the United States to remain competitive in the world marketplace. The development of mathematical problem solving, reasoning, and communication skills is essential so that people can skillfully address the more complex problems encountered in today's workplaces.

Societal needs

In the early part of this century, the needs of our society were dominated by an emerging industrial age driven by mass production. The needs of that society were served by mathematics education in which the acquisition of computational skills was the primary focus. In the coming century the educational needs of our society will be very different. The economy is global, the economic environment is more competitive, and the workforce is more mobile. The acquisition of computational skills remains important, but more is needed today, due to rapidly changing technology. We need individuals who can apply their understanding of mathematics to solve real-life problems for which there are no simple formulas and standard procedures. We need individuals who can use their knowledge of mathematics to make sense of complex situations and then communicate that understanding to others. We need individuals who are able to solve tomorrow's problems, as well as today's. Mathematics education for the twenty-first century must address these needs.

Societal goals

We believe the goals for New Hampshire schools are closely aligned with those espoused by various national commissions and groups in their efforts to reshape the mathematics curriculum. We commit to three primary goals. That

(1) *all students* develop strong mathematical problem solving abilities;
(2) *all students* develop positive attitudes and beliefs about mathematics;
(3) *all students* develop the ability to communicate their understanding of mathematics effectively.

How children learn mathematics

We agree with current research that K-4 mathematics education will best serve societal needs when the curriculum is conceptually focused. When children learn mathematics by exploring and discussing concepts in the context of physical situations, what emerges from these experiences are skills which are anchored in understanding. The students not only know the basic procedures but also how to apply them to new situations.

The attitudes children form influence their thinking and performance, and, later, influence their decisions about studying mathematics. Young children are active individuals who construct, modify, and integrate ideas by interacting with materials, the world around them, and their peers. Thus, the learning of mathematics must be an active process: exploring, justifying, representing, solving, constructing, discussing, using, investigating, describing, developing, and predicting. These actions require both the physical and mental involvement of children -- both hands on and minds on.

Such a curriculum has the following characteristics:

*children are actively involved in doing mathematics;
*problem solving, thinking, reasoning, and communicating are everyday activities;
*manipulatives are used to connect procedural to conceptual understanding;
*calculators and computers are used in appropriate ways;
*there is as much emphasis on application as on acquisition of knowledge and skills;
*a broad range of content is addressed; and
*central mathematical concepts are understood.

A VISION

LIFELONG LEARNING;
MATHEMATICALLY LITERATE AND NUMERATE CITIZENS;
OPPORTUNITY FOR ALL;
and
AN INFORMED ELECTORATE.

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THE STUDY OF MATHEMATICS
WILL ENABLE CHILDREN TO:

LEARN TO VALUE MATHEMATICS AND SEE ITS MANY CONNECTIONS;
BECOME CONFIDENT IN THEIR ABILITY TO DO MATHEMATICS;
BECOME MATHEMATICAL PROBLEM SOLVERS;
LEARN TO COMMUNICATE MATHEMATICALLY;
and
LEARN TO REASON MATHEMATICALLY.

GOALS AND OUTCOMES

PROBLEM SOLVING AND REASONING

1a. Curriculum Goal: Children will use problem-solving strategies to investigate and understand increasingly complex mathematical content.

PURPOSE: Problem solving should serve as the organizing feature of the mathematics curriculum as well as other areas of study and be applied to everyday activities. Problem-solving must not be seen as a separate topic, but rather the centerpiece of the mathematics curriculum. Children should have many experiences in posing and solving problems from their world, from data that is meaningful to them, and from mathematical investigations. Problem situations should give rise to mathematical concepts.

Performance Outcomes:

-Solve problems using a variety of strategies, such as: make a list; draw a picture; look for a pattern; use a calculator; or use manipulatives.
-Formulate and solve real-world problems.
-Solve multi-step problems.
-Use problem-solving approaches to investigate and understand mathematical content.
-Verify and interpret results with respect to the original problem.
-Demonstrate understanding that a problem may be solved in more than one way.
-Exhibit confidence in their ability to solve problems independently and in groups.
-Display perseverance and persistence in solving problems.
-Write about problem solutions and solution processes.

Performance Indicators:

Formulate problems from everyday and mathematical situations.
Solve problems that require the use of strategies such as making a list, drawing a picture, looking for a pattern, etc.
Use manipulatives and calculators to solve problems.
Investigate new mathematical situations using previously-learned knowledge.

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1b. Curriculum Goal: Children will use mathematical reasoning.

PURPOSE: Children need to recognize that memorized facts, rules, and procedures are only a small part of mathematics. They need opportunities to make conjectures, develop and refine their reasoning abilities, gather evidence, and produce valid rules and generalizations. Children need to be able to justify their thinking and appreciate that how a problem is solved is as important as the answer.

Performance Outcomes:

-Draw conclusions using inductive reasoning.
-Explain thinking by using models, known facts, properties, and relationships.
-Justify conjectures, solution processes, and answers.
-Demonstrate belief that mathematics makes sense.
-Demonstrate conservation of number and length by using reversibility of thought.

Performance Indicators:

Use addition or subtraction to continue a number pattern.
Identify the missing information needed to find a solution to a given story problem.
Compare and contrast geometric figures.
Verify an answer to a problem.
Use knowledge of geometric properties to continue a pattern.
Defend a conjecture with an appropriate argument.

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1c. Curriculum Goal: Children will use estimation skills and strategies, and know when it is appropriate to do so.

PURPOSE: Children should know what is meant by estimation, when it is appropriate to estimate, and how close an estimate is required in a given situation. Children should be encouraged to estimate the solution of problems before computation or measurement is done, and to use estimation to determine the reasonableness of answers, and to recognize when an estimate is sufficient as an answer.

Performance Outcomes:

-Use a variety of estimation strategies when solving problems.
-Determine the reasonableness of answers for problems involving arithmetic operations.
-Use estimation and mental computation to solve problems where exact answers are not required.

-Estimate appropriate units of measurement.
-Estimate or predict an approximate solution to a problem.
-Communicate the strategies used in estimation based upon previous experiences.
-Recognize when estimating versus finding an exact answer to a problem is appropriate.
-Use estimation to determine the reasonableness of a calculation done by calculator or computer.

Performance Indicators:

Determine the reasonableness of answers for problems involving addition and subtraction.
Use estimation and mental computation to solve problems where exact answers are not required.

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1d. Curriculum Goal: Children will recognize patterns and relationships and use them to make predictions and solve problems.

PURPOSE: Patterns abound everywhere and children should be encouraged to look for them. Their recognition leads children to understand how mathematics applies to the world in which they live. Patterns help children organize and classify information. Relating patterns in numbers, geometry, and measurement helps children understand the connections among mathematical topics. The identification of connections fosters sound mathematical thinking that will assist students with problem solving and more abstract ideas studied in later grades. Discovering patterns and relationships is the essence of mathematics and the idea of functional relationships can be intuitively developed through such observations.

Performance Outcomes:

-Use concrete models to create a pattern, describe the pattern, and represent the pattern symbolically in a table.
-Recognize, describe, extend, and create a wide variety of patterns.
-Represent and describe mathematical relationships.
-Explore the use of variables and open sentences to express relationships.
-Discover patterns or relationships from graphical representations.

Performance Indicators:

Recognize and describe patterns that involve numbers and shapes.
Create patterns.
Write an open sentence (equation) to express a relationship.

COMMUNICATION AND CONNECTIONS

2a. Curriculum Goal: Children will communicate their understanding of mathematics.

PURPOSE: Reading, writing, talking, listening, and modeling, provide children with the opportunity to integrate the language of mathematics into their world, and help them to develop understanding. Actively exploring, investigating, describing, and explaining mathematical ideas promote communication which leads to a greater comprehension of mathematical concepts.

Performance Outcomes:

- -Relate everyday language to mathematical language and symbols.
- -Discuss, illustrate, and write about mathematical concepts and relationships.
- -Use language to reflect on, clarify, and articulate thinking about mathematical ideas and situations.
- -Demonstrate mathematical communication through discussion, reading, writing, listening, and responding, individually and in groups.

Performance Indicators:

Discuss mathematical concepts and relationships.
Draw pictures and use objects to illustrate mathematical concepts.
Write about the mathematical topics presented at this level.
Defend conjectures and tentative generalizations.

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2b. Curriculum Goal: Children will recognize, develop, and explore mathematical connections.

PURPOSE: Mathematical topics, ideas, and procedures need to be seen as connected to each other and to the children's everyday experiences, both in and out of school. Mathematics needs to be viewed as connected to all other curriculum areas. Mathematical connections help children become aware of the usefulness of mathematics, serve to bridge the concrete and the abstract, and enable deeper understanding of important ideas.

Performance Outcomes:

- -Understand mathematical processes and relate them to one another.
- -Recognize different representations of concepts and procedures.
- -Translate among representations as appropriate.

-Recognize relationships among different topics in mathematics.
-Recognize and use mathematics in other curriculum areas.
-Recognize and use mathematics in their daily lives.

Performance Indicators:

Recognize and develop the relationship between addition and multiplication.
Recognize and develop the relationship between fractions and decimals.
Recognize and develop the mathematical situations occurring in children's literature.
Recognize and develop mathematical applications in social studies, such as graphs, tables, and map skills.
Recognize and develop the use of mathematical skills and concepts in science, such as measurement, graphs, and data analysis.
Recognize and develop the use of geometry in nature, art, and architecture.
Recognize and develop the use of probability and statistics to describe and predict events that occur in nature.
Recognize and develop the use of money in real-life situations.
Recognize and develop geometric representations for fractions, decimals, and arithmetic operations.

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NUMBERS, NUMERATION, AND OPERATIONS

3a. Curriculum Goal: Children will develop number sense and an understanding of our numeration system.

Purpose: Children must understand numbers if they are to make sense of the ways numbers are used in their everyday world. They need to use numbers to quantify, to identify location, to identify a specific object in a collection, to name, and to measure. They need to understand relative magnitude in order to make sense of everyday situations.

Performance Outcomes:

-Read and write whole numbers.
-Show understanding of place value concepts via the use of physical models.
-Recognize and demonstrate the difference in magnitude of numbers.
-Demonstrate knowledge of differences in the use of ordinal and cardinal numbers.
-Recognize the effect of performing the operations of addition, subtraction, multiplication, and division with whole numbers.
-Use a reference system for measures of common objects and situations in the student's environment.

-Interpret the multiple uses of numbers encountered in the real world.

Performance Indicators:

Identify and write a 3-digit number given a physical model or an illustration of a place-value model, and given a 3-digit number, create a model.
Given the number of hundreds, tens, and ones, identify and write a 3-digit number.
Given a 3-digit number, identify the number of hundreds, tens, and ones.
Identify any 3-digit number in various combinations of hundreds, tens, and ones.
Identify the number 1000 as a unit or in various combinations of hundreds, tens, and ones.
Explain the use of numbers in various every-day contexts; e.g., calendars, clocks, signs, and literature.

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3b. Curriculum Goal: Children will understand the concepts of whole number operations.

PURPOSE: Children need to build an awareness of the properties of an operation, see relationships among operations, and acquire insight into the effects of operations on whole numbers. Children need to recognize conditions in real world situations where the use of these operations is indicated and useful.

Performance Outcomes:

-Develop meaning for the operations of addition, subtraction, multiplication, and division by modeling and discussing a rich variety of problem situations.
-Demonstrate and explain the relationship between these operations.
-Relate the mathematical language and symbols to problem situations and informal language.
-Recognize that a wide range of problem situations can be represented by one expression.

Performance Indicators:

Count by ones, twos, fives, and tens.
Identify even and odd numbers and explain the difference.
Order a set of numbers (0-99) from smallest to largest.
Name the whole number immediately before or after any 2-digit number.
Name the number that is ten units before or ten units after any 2-digit number.
Compare any two 2-digit numbers to determine which is greater or less.
Recognize the special properties of 0 and 1.

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3c. Curriculum Goal: Children will compute with whole numbers.

PURPOSE: The purpose of computation is to solve problems. While computation remains important in mathematics and in everyday life, advances of technology require us to rethink how computation is done today. Children must recognize that estimation, mental computation, use of calculators, and paper and pencil calculation are all appropriate ways to compute solutions to problems. Basic fact memorization should be incorporated into a rich curriculum rather than be its primary focus.

Performance Outcomes:

-Model, explain, and develop proficiency with basic facts and algorithms.
-Use a variety of mental computation and estimation techniques.
-Use calculators in appropriate computational situations.
-Given a problem, select an appropriate computational technique to solve the problem and determine the reasonableness of the result.

Performance Indicators:

Use manipulatives to develop a subtraction algorithm.
Subtract any two 2-digit numbers with or without renaming.
Use manipulatives to illustrate an addition algorithm for numbers less than 1,000.
Add any two or more whole numbers less than 1,000.
Add or subtract 3- and 4-digit numbers using a calculator.
Use manipulatives to illustrate a subtraction algorithm of two numbers with subtrahend less than 1,000.
Use manipulatives and pictures to represent multiplication as repeated addition or arrays.
Demonstrate mastery of the multiplication facts with factors less than or equal to 5.
Use manipulatives and pictures to represent division as the sharing of objects and as the number of groups of shared objects.

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3d. Curriculum Goal: Children will develop a sense of fractions and decimals and explore operations with them.

PURPOSE: Fractions and decimals are often encountered in real world settings. When children understand fractions and decimal concepts and their operations, they can use this knowledge to describe and interpret real-world phenomena. It is extremely important that instruction in these areas reflect real-life situations and provide the children with opportunities to model and investigate fractions and decimals. Children should also explore the operations of addition and subtraction of fractions and decimals using manipulatives.

Performance Outcomes:

-Identify fractions and decimals using physical models.

-Investigate and develop an understanding of different physical representations for the same fraction.

-Investigate and develop an understanding of the relationships among fractions.

-Represent whole numbers as fractions.

-Explore and develop the concepts of addition and subtraction of fractions and decimals using manipulatives.

Performance Indicators:

Given a region divided into congruent parts, name and write a fraction to represent a shaded portion.

Given a set of objects, name and write a fraction to represent a subset.

Given a set of fractional models, name and write those that represent equivalent fractions.

Given a fraction, use physical models or illustrations to represent equivalent fractions.

Given a pair of fractions, determine which is larger or smaller by using physical models or illustrations.

Given physical models or illustrations, name and write a decimal to represent tenths and hundredths.

Given a decimal representing tenths, represent it as a fraction using place-value models.

Using physical models and illustrations, determine the sum or difference of fractions with like or unlike denominators.

Using physical models and illustrations, determine the sum or difference of decimals.

Develop and use algorithms to add and subtract decimals.

GEOMETRY AND MEASUREMENT

4a. Curriculum Goal: Children will name, describe, model, classify,, and compare geometric objects.

PURPOSE: The study of geometry is an important part of the primary curriculum and serves as a natural link to the integration of mathematics across the curriculum. Geometry helps children represent and describe the world in which they live. When learning geometry, students need to investigate, experiment, and explore with everyday objects, as well as other hands-on materials such as tangrams, geoboards, blocks, polyhedra models, and mirrors.

Performance Outcomes:

-Name, model, describe, and classify cubes, spheres, cones, cylinders, pyramids, and rectangular solids.

-Name, model, describe, and classify circles, rectangles, squares, triangles, trapezoids, parallelograms, kites, and rhombuses (diamonds).

-Name, model, describe, and classify right, acute, obtuse, and straight angles.

-Determine when pairs of figures are congruent.

-Determine the presence or absence of lines of symmetry for given figures.

Performance Indicators:

Use the terms points, lines, and line segments in describing two-dimensional lines.
Draw line segments and lines.
Draw lines of symmetry.
Determine if two-plane figures are congruent by matching.
Identify, describe, and draw a kite.
Identify and describe pyramids.

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4b. Curriculum Goal: Children will develop spatial sense.

PURPOSE: Students live in a three-dimensional world. In order to interpret, understand, and appreciate that world, they need to develop an understanding of space. More importantly, research suggests that there is a high correlation between spatial abilities and success in mathematics. Spatial skills include making and interpreting drawings, forming mental images, visualizing changes, and generalizing about perceptions in the environment.

Performance Outcomes:

-Use position terms such as inside, outside, above, etc.
-Copy and make shapes by drawing and using manipulatives, such as pattern blocks and tangrams.
-Draw, compare, and visualize shapes in various positions.
-Investigate and predict results of combining, subdividing, and changing shapes using manipulatives, such as pattern blocks and tangrams.
-Construct various three-dimensional objects.
-Describe and/or draw three-dimensional objects from different perspectives.

Performance Indicators:

Divide and separate a shape into smaller shapes.
Recognize and make shapes that can be created from a set of three simple shapes.
Identify congruent figures.
Draw figures congruent to a given figure.
Construct three-dimensional objects.

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4c. Curriculum Goal: Children will measure using standard and nonstandard units.

PURPOSE: Measurement is used in many ways throughout a child's life. When learning about measurement, children begin with comparisons. Initially, nonuniform measures, such as length of a child's foot, or pencils of different length, are used to motivate the need for a uniform unit of measure. This leads to the use of nonstandard but uniform units, like paper clips, pennies, or chalkboard erasers. Finally the student is introduced to the standard units of measure used in the metric and English systems. In the K-3 curriculum, children should estimate and measure length, area, capacity, volume, weight, time and temperature, as well as discover practical uses of these skills. This goal should be carried out with constant use of measuring items and in a context of problem solving.

Performance Outcomes:

-Understand the need for a uniform unit of measure.
-Develop measuring skills.
-Investigate the attributes of length, area, capacity, volume, and weight using standard (metric and English) and nonstandard units of measure.
-Understand the attributes of time and temperature.
-Relate measurement ideas to geometric ideas.
-Develop the concepts of perimeter and area.

-Make and use estimates of measurement.
-Represent monetary amounts in a variety of ways and make exchanges for these amounts.

Performance Indicators:

Tell time to the nearest minute.
Measure line segments to the nearest half inch and quarter inch.
Investigate perimeters.
Add units of length that may or may not require regrouping of inches to feet or centimeters to meters.
Estimate weight using pounds or kilograms.
Estimate capacity using quarts, gallons, or liters.
Given a standard unit, estimate and measure the area of a rectangular region.
Given a standard unit, estimate the area of any region.
Investigate the addition of hour and half-hour time intervals.
Given an amount of money, determine if a purchase can be made.

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DATA ANALYSIS

5. Curriculum Goal: Children will use data analysis and probability to analyze given situations and the outcomes of experiments.

PURPOSE: Collecting, organizing, displaying, and interpreting data, as well as using the information to make decisions and predictions, have become very important in our society. Statistical instruction should be carried out in a spirit of investigation and exploration so children can answer questions about the data. Probability must be studied in a real world setting. Students need to investigate fairness, chances of winning, and uncertainty.

Performance Outcomes:

-Collect, organize, describe, and interpret data.
-Formulate and solve problems that involve collecting, organizing, and analyzing data.
-Predict outcomes and carry out simple activities involving probability.
-Determine which event is most likely or least likely to happen, given appropriate information.

Performance Indicators:

Collect data, construct, and interpret picture and bar graphs.
Interpret circle graphs.
Write a story problem using information from a graph.
Given appropriate information, determine which is most likely to happen or whether one event is more likely than another.

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CONTRIBUTORS

Roberta Barrett
Member, State Board of Education
Nashua

Jane Brandt
Teacher, St. Paul's School
Concord

Dan Bisaccio
Coordinator, Mathematics and Science
Souhegan Regional HS, Amherst

Dr. Richard Evans
Professor of Mathematics
Plymouth State College, Plymouth

Deborah Gibbens
Teacher, Reeds Ferry School
Merrimack

Kris Lynes
Teacher, Oyster River Elementary School
Durham

Signe McQuaid
Member, NH Assessment Planning Committee
Manchester

William B. Ewert
Bureau Administrator
NH Department of Education

Charles H. Marston
Commissioner
NH Department of Education

Arthur V. Johnson, II
Teacher, Nashua High School
Nashua

Kathy Treamer
Teacher, Groveton Elementary School
Groveton

Dr. Fernand J. Prevost
Curriculum Supervisor, Mathematics
NH Department of Education

Fred Bramante
Chair, NH Assessment Planning Committee
Durham

Dr. Tom Bassarear
Professor of Mathematics
Keene State College, Keene

Raymond D'Amante
Member, State Board of Education
Concord

Dr. Donald Kreider
Professor of Mathematics
Dartmouth College, Hanover

Candace Chaplain
Teacher, The Derryfield School
Manchester

Robin Reilly
Teacher, Fisk Elementary School
Salem

Susan Winkler
Member, State Board of Education
Peterborough

Sr. Jeannette Landreville
Teacher, St. Catherine School
Manchester

Ann Pinto
Teacher, Hampstead Central School
Hampstead

Elizabeth Erickson
Teacher, Kearsarge Schools
Bradford

Doug Pearson
President, NSS Corporation
Bedford

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